Claims

1. *A passively stabilized wheeled luggage apparatus comprising:*

a luggage container,

at least one primary wheel assembly comprising two wheels, spaced apart from each other and mounted to the luggage container to rotate about a common primary axis, such that upon contact of the wheels with a surface, the primary wheels can roll along the surface to effect movement of the luggage container in a direction perpendicular to the common primary axis,

at least one secondary wheel assembly comprising two secondary wheels, disposed on opposite sides of, and spaced further apart than the wheels of the primary wheels assembly,

each of the secondary wheels rotating about a secondary axis,

such that tilting of the device during rolling causes one of the secondary wheels to contact the surface and counteract the tilting.

2. The apparatus of claim 1 wherein each of the secondary wheels is canted relative to a corresponding primary wheel.

3. The apparatus of claim 2 wherein each of the secondary wheels is canted outward relative to a corresponding primary wheel.

4. The apparatus of claim 1 wherein the secondary axis of each of the secondary wheels is displaced vertically from the primary axis of the primary wheels.

5. The apparatus of claim 1 wherein the secondary axis of each of the secondary wheels is displaced laterally from the primary axis of the primary wheels.

6. The apparatus of claim 1 wherein the diameter of each of the secondary wheels is smaller than the diameter of the primary wheels.

7. The apparatus of claim 1 wherein the apparatus further comprises more than one set of secondary wheels.

8. The apparatus of claim 1 wherein the angular offset of the secondary axis, excluding vertical and lateral displacements, ranges between about 5 degrees and about 55 degrees.

9. The apparatus of claim 1 wherein the angular offset of the secondary axis, excluding vertical and lateral displacements, ranges between about 10 degrees and about 40 degrees.

10. The apparatus of claim 1 wherein the secondary wheels rotate about secondary axels that are independently mounted to the luggage container.

11. A passively stabilized wheeled object comprising

an object body;

at least one primary wheel assembly comprising two wheels, spaced apart from each other and mounted to the object body to rotate about a common axis, the primary wheel assembly being defined by a first set of coordinates x_l, y_l and z_l, wherein x_l is the direction of motion, y_l is vertical and z_l is the direction along the common axis of the primary wheel assembly and a second set of coordinates x, y and z defined relative to the earth, such that when the object is at rest, the coordinates x, y and z substantially match x_l, y_l and z_l; and

at least one secondary wheel assembly comprising at least two secondary wheels, disposed on opposite sides of, and spaced further apart than the wheels of the primary wheels assembly, each of the secondary wheels is further defined by a cant axis which is substantially similar to the y axis and an angle ψ representing rotation about the cant axis relative to the x axis, the ψ angle thus defining the orientation of the secondary wheel relative to a primary wheel and being chosen to restore stability if the object tips.

12. The apparatus of claim 11 wherein the cant axis is defined by an angle ξ which is the angle between the coordinate axis x_l and the cant axis, and expressed in the coordinates system attached to the luggage as follows:

$$x_l = \cos \xi$$

$$y_l = \sin \xi$$

$$z_l = 0.$$

13. The apparatus of claim 12 wherein the angle ξ is chosen in the vicinity of 90-ϕ degrees, where ϕ is the "usual" pitch angle of the luggage when towed by its user and further defined as follows

$$x_l = \cos \xi \cos \zeta$$
$$y_l = \sin \xi \cos \zeta$$
$$z_l = \sin \zeta,$$

where ζ is a small angle less than 40 degrees in absolute value.

14. The apparatus of claim 11, wherein the absolute value of the angle ψ is in the range of about 5 degrees to about 55 degrees.

15. The apparatus of claim 11, wherein the absolute value of the angle ψ is in the range of about 10 degrees to 40 degrees.

16. The apparatus of claim 11 wherein the primary wheels rotate about a primary axis and the secondary wheels rotate about secondary axes, and wherein the secondary axis of each of the secondary wheels is displaced vertically from the primary axis of the primary wheels.

17. The apparatus of claim 11 wherein the primary wheels rotate about a primary axis and the secondary wheels rotate about secondary axes, and wherein the secondary axis of each of the secondary wheels is displaced laterally from the primary axis of the primary wheels.

18. The apparatus of claim 11 wherein the diameter of each of the secondary wheels is smaller than the diameter of the primary wheels.

19. The apparatus of claim 11 wherein the apparatus further comprises more than one set of secondary wheels.

20. The apparatus of claim 21 wherein the secondary wheels rotate about secondary axels that are independently mounted to the object.

21. A stabilization device for a wheeled object having two primary wheels which rotate about a common axis to move the object along a surface by rolling, the stabilization device comprising:

a set of two secondary wheels, disposed on opposite sides of, and external to, the primary wheels,

each of the secondary wheels rotating about a secondary axis that is angled away from the from the common axis of the primary wheels,

and wherein the diameters of the secondary wheels are smaller than the diameters of the primary wheels,

such that tilting of the object during rolling causes one of the secondary wheels to contact the surface and counteract the tilting.

22. The device of claim 21 wherein the positioning of the secondary wheel with respect to the adjacent primary wheel is defined by coordinates x_s, y_s, z_s and D_p is the diameter of the primary wheels and D_s is the diameter of the secondary wheels, such that the following equation is satisfied:

$$z_s > D_s/2 \sin \psi.$$

wherein ψ is an angle representing orientation of the secondary wheel about a cant axis

23. The device of claim 22 wherein z_s is less than 30% of the total width of the object.

24. The device of claim 21 wherein the positioning of the secondary wheel with respect to the adjacent primary wheel is defined by coordinates x_s, y_s, z_s and D_p is the diameter of the primary wheels and D_s is the diameter of the secondary wheels, such that the following equation is satisfied:

$$D_s/2 + y_s \cos \phi + x_s \sin \phi \leq D_p/2$$

25. The device of claim 21 wherein the positioning of the secondary wheel with respect to the adjacent primary wheel is defined by coordinates x_s, y_s, z_s and D_p is the diameter of the primary wheels and D_s is the diameter of the secondary wheels, and D_s ranges from about 0.1 to about 1.5 D_p.

26. The device of claim 21 wherein the primary wheels share an axel disposed along the common axis.

27. The device of claim 21 wherein the primary wheels rotate about separate axels disposed along the common axis.

28. The device of claim 21 wherein the secondary wheels each rotate about secondary axels that are joined to an axel of an associated primary wheel.

29. The device of claim 21 wherein each secondary axis angles in an upward direction with respect to the axis of an adjacent primary wheel.

30. The device of claim 21 wherein each secondary axis angles in a outward direction with respect to the axis of an adjacent primary wheel.

31. The device of claim 21 wherein the positioning of the secondary wheel with respect to the adjacent primary wheel is defined by coordinates x_s, y_s, z_s and D_p is the diameter of the primary wheels and D_s is the diameter of the secondary wheels, and wherein an average pitch angle is defined as ϕ_0, such that x_s and y_s are selected according the formula:

$$y_s = (D_p - D_s)/2 \cos \phi_0 - \varepsilon_y \text{ and}$$
$$x_s = (D_p - D_s)/2 \sin \phi_0 - \varepsilon_x ,$$

where ε_y and ε_x are two small numbers each less than 20 millimeters.

32. A method of passively stabilized wheeled luggage comprising:

incorporating at least one secondary wheel assembly into a luggage container, the container having at least one primary wheel assembly comprising two wheels, spaced apart from

each other and mounted to the luggage container to rotate about a common primary axis, such that upon contact of the wheels with a surface, the primary wheels can roll along the surface to effect movement of the luggage container in a direction perpendicular to the common primary axis, wherein the secondary wheel assembly comprising at least two secondary wheels, disposed on opposite sides of, and spaced further apart than the wheels of the primary wheels assembly, and

mounting each of the secondary wheels rotating about a secondary axis distinct from the primary axis,

such that tilting of the device during rolling causes one of the secondary wheels to contact the surface and counteract the tilting.

33. The method of claim 32 wherein the step of mounting the secondary wheels further comprises mounting each of the secondary wheels such that is canted outward relative to a corresponding primary wheel.

34. The method of claim 32 wherein the step of mounting the secondary wheels further comprises mounting each of the secondary wheels such that is canted forward relative to a corresponding primary wheel.

35. The method of claim 32 wherein the step of mounting the secondary wheels further comprises mounting each of the secondary wheels such that the secondary axis of each of the secondary wheels is displaced vertically from the primary axis of the primary wheels.

36. The method of claim 32 wherein the step of mounting the secondary wheels further comprises mounting each of the secondary wheels such that the secondary axis of each of the secondary wheels is displaced laterally from the primary axis of the primary wheels.

37. The method of claim 32 wherein the method further comprises selecting secondary wheels such that the diameter of each of the secondary wheels is smaller than the diameter of the primary wheels.

38. The method of claim 32 wherein the method further comprises mounting more than one set of secondary wheels.

39. The method of claim 32 wherein the step of mounting the secondary wheels further comprises mounting each of the secondary wheels such that the angular offset of the secondary axis, excluding vertical and lateral displacements, ranges between about 5 degrees and about 50 degrees.

40. The method of claim 32 wherein the step of mounting the secondary wheels further comprises mounting each of the secondary wheels such that the angular offset of the secondary axis, excluding vertical and lateral displacements, ranges between about 10 degrees and about 40 degrees.

41. The method of claim 32 wherein the step of mounting the secondary wheels further comprises mounting each of the secondary wheels such that the secondary wheels rotate about secondary axels that are independently mounted to the luggage container.